UNIVERSITY OF TURKU

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ICLEI GREEN CIRCULAR CITIES COALITION

Feasibility Study to Build an Active Network of Circular Economy Actors in the Turku Region

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SUMMARY

The City of Turku and Finland Futures Research Centre have conducted a joint feasibility study to determine the preconditions for the Turku region to take part in the Green Circular Cities Coalition initiated by ICLEI – Local Governments for Sustainability.

Circular economy was examined through the six thematic sectors determined by ICLEI: urban spatial planning and governance, circular public procurement and supply chain, circular industrial park, municipal resource management, buildings and construction and water-food-energy nexus. Circular economy was recognised widely through the operations aimed at increasing resource efficiency and transitioning from a linear economy paradigm to a circular one, for example renewable energy sources, recycling, reuse, sharing platforms, bio economy and cleantech.

Turku urban spatial planning has implemented circular economy solutions in its master plan by planning new residential areas in old industrial areas located near the city centre and having access to public transportation. A more specific city plan requires construction companies to build circularity-advancing solutions, making the structure of the city denser and intensifying the implementation of life cycle assessment. Transportation and street planning are moving towards more environmentally neutral public transportation and sharing solutions for more efficient use of bikes and other vehicles. Green area planning has employed a new method called “blue-green factor” which determines the minimum amount of green areas in a property in relation to living areas. Stormwater directing solutions have also been intensified. Circular economy is a strong theme in the three spearhead projects of the City of Turku; Development of the city centre, Turku Science Park development and Smart and Wise Turku.

On 11 June 2018, the Turku City Council approved the climate plan, which sets carbon neutrality by 2029 as the main target of its climate policy. Through the development work of its strategic entities, the City of Turku has been the local engine for advancing circularity. The general atmosphere towards climate actions among residents and officials of the city of Turku is positive, which is good, since a lot of participation, solutions and work is required to reach the ambitious climate goals.

Public procurement has the responsibility to set an example and the power to be a substantial influencer in developing corporate operations towards circularity. Challenges for advancing public procurement include tight legislation in tendering, lack of impartial quality criteria and follow-up systems and the low degree of readiness of circular economy products available on the market. The strategic procurement department of Turku is working with a “guide for sustainable procurement”, which aims to advance tendering quality criteria to support a sustainable procurement process.

The main industrial fields of the Turku region are bio, ICT, marine and metal industries, construction and logistics, all with great potential for circular economy advancement. Bio-economy includes chemistry, medicine and food industries, agriculture and strong research in these fields. Turku Science Park Oy, a strategic entity of Turku, operates through its Clean team in innovation co-creation with local corporations, thus advancing industrial symbiosis. Turku University of Applied Sciences has a strong standing in circular economy business model creation and co-operation with local companies. Larger corporations have been aware of circularity and active in creating solutions for a long time. Smaller companies have less resources, but they are able to join circular operations through subcontracting.

The municipal waste management of Turku is a joint solution of 17 municipalities with 12 waste centres and waste separation stations with Topinpuisto as the centre and showroom of circular economy. In 2021, a new ecological waste burning power plant will be opened in Salo, near Turku. A relevant field of action in the Turku area is textile recycling, which has been advanced through numerous projects. A pilot plant for textile recycling is being opened in Turku and the aim is to open a larger scale plant in the coming years.

Approximately one third of greenhouse gas emissions is from buildings and construction, which gives them a central role in achieving the climate goals. Building circularity can be determined by the master plan and plot transfer clauses to some extent, which gives the city a substantial opportunity to guide construction company operations towards circularity. The city builds infrastructure and green areas in which the circularity of land masses is a considerable theme. The life cycle energy consumption of a building can be significantly affected through the planning and building phases. Circular solutions regarding existing buildings are improvement of energy efficiency, increasing the usage of space, making the life of a building longer through maintenance, renovation and restructuring or changing the purpose of use. End-of life-circularity considers how to circulate and reuse the building materials.

The water-food-energy nexus is an internationally significant theme, since water is one of the most endangered resources and food and energy production are among the most polluting industrial sectors. The Turku region possesses substantial knowledge in the circular waste water purification system, which creates more energy than it consumes. Water-related themes are regionally strong through Baltic Sea protection and research. The Turku region is one of the centres of agriculture, food chains and food production, where research is strong and circularity is an important theme. The varieties cultivated in Southwest Finland are very diverse, which also helps the area prepare for climate change. In energy production, the focus is on increasing renewable sources, utilising waste energy of industrial processes, energy storage and increasing energy efficiency solutions. Energy research is strong in the universities of the Turku area.

As part of this feasibility study, the readiness of local actors to participate in the ICLEI GCCC co-operation was assessed. Most of the actors interviewed were interested. Some were even enthusiastic towards the co-operation, asserting that the contents need to be concrete and advance circular solutions in the Turku region. Turku possesses interesting contents in each thematic sector that can be included in the co-operation. Before the final selection of thematic sectors, it is important to discuss and agree with local actors, whether to select contents in which Turku is already strong or contents where Turku needs clear support from the network. Before conclusion it would also be interesting to communicate with other cities and find out what themes and which sectors they will bring to GCCC in order to create meaningful and influential co-operation.

INTRODUCTION

The City of Turku has set as its objective to be a carbon neutral city by its 800th anniversary in 2029. This objective will be followed by climate positivity, a goal that the Sustainable development partnership[1] agreement between the City of Turku and Sitra on 1 February 2019 also strives for. Implementing circular economy is a key instrument for attaining climate positivity.

ICLEI – Local Governments for Sustainability (International Council for Local Environmental Initiatives) is an international network consisting of over 1500 cities and sub-regional units from approximately 125 countries that have committed to building a sustainable future. ICLEI invites local actors and local governments to participate in the activities of its international network and aims at influencing their operating models and legislation to find more sustainable solutions in the five sectors of sustainable development. The Circular Development Pathway is the most recent sector of sustainable development in ICLEI's work. ICLEI has invited 12 cities with advanced circular economy solutions to develop the first phase of Circular Economy Development. One of these 12 cities is Turku[2]. Together, these cities will form the Green Circular Cities Coalition, GCCC.

In order to have a comprehensive overview of the potential of Turku to be part of the circular economy coalition of ICLEI, the City of Turku and Finland Futures Research Centre initiated a feasibility study in November 2018 as a shared project. The objective was to map out actors of circular economy in the Turku region and to analyse local circular economy activities within the framework of the six thematic sectors determined by ICLEI.

This report introduces the key observations of the study by theme, based on public sources of information and interviews with key persons. In addition to the ICLEI themes, the report highlights the role of data as a subject matter encompassing all themes. The report also highlights education in the Turku region that supports circular economy.

[1] https://www.turku.fi/uutinen/2019-02-01_sitra-ja-turku-tekevat-ilmastopositiivista-kaupunkia on 19 February 2019

[2] https://www.iclei.org/ on 19 February 2019

The framework of ICLEI circular economy actors and practical measures to attain circular economy

Picture 1. *ICLEI thematic sectors and practical measures*[3]

ICLEI has determined six thematic sectors to implement circular economy.

1) urban spatial planning and governance
2) green/circular public procurement and supply chain
3) circular industrial park (industrial symbiosis)
4) municipal resource management
5) buildings and construction
6) water-food-energy nexus

The six circular economy actions determined by ICLEI consist of the following: recycle, recover, redesign, remanufacture, repair, reuse. Measures or business models have not been analysed or particularly highlighted in the study but different forms of circular economy have been approved as part of implementing circular economy in accordance with these principles.

In addition, Sitra's perception of circular economy has been used as a basis for the study. This outlook where circular economy is perceived through five business models[4] is more familiar to Finnish actors.

[3] Green Circular Cities Coalition Concept (2018) ICLEI, 5

[4] https://nyvuosiyrittajana.fi/wp-content/uploads/2018/04/Kiertotalouden_liiketoimintamalleja_Sitra.pdf on 19 February 2019

1) Product-life extension
2) Product as a service
3) Sharing platforms
4) Renewability
5) Resource efficiency and recycling

Conducted by Valonia (Service centre for sustainable development and energy of Southwest Finland), the regional circular economy roadmap[5] published in the spring of 2017 was divided into three focus areas:

1) sustainable food system (waste reduction, appreciation of local food, circulation of nutrients, sustainable farmland and clean bodies of water)
2) technical loops (sustainable use of materials and products, renewable energy solutions)
1) transport and logistics (servicising, applications and new sources of energy).

When these are combined with cross-cutting themes in the roadmap i.e. public procurement servicising and know-how in chemistry, it can be stated that the regional circular economy roadmap of Southwest Finland has quite comprehensively described the thematic sectors determined by ICLEI and the concrete actions that are needed to advance circular economy. A sustainable food system complemented with know-how in chemistry describes the water-food-energy nexus theme. Technical loops complemented with know-how in chemistry include areas of both construction and industrial symbioses. They also include the energy theme of the water-food-energy nexus. Transport, logistics and servicising are included in the theme of urban spatial planning. In the ICLEI framework, public procurement appears as a theme of its own and so does municipal resource management. ICLEI is a network of cities and for this reason, the themes of ICLEI are more city oriented than in the regional roadmap of Southwest Finland.

ICLEI has instructed the cities entering the circular economy coalition to do the following:

- to analyse the level of circular economy operations in the city
- to operate in a way that advances opportunities of circular economy
- to accelerate and extend the transition from linear economy to circular economy[6]

Of the six thematic sectors, the cities taking part in the circular economy coalition will pick one to three sectors. They will then begin to develop and spread functions in these sectors together with the ICLEI network.

The thematic sectors of ICLEI form a network where a large part of circular economy operation in the region can be considered to fall under more than one theme. There is a blurred line between urban spatial planning and buildings and construction. From the point of view of the city, both are related to public procurement and investments. A key component of construction is private businesses and the circular economy of materials that may form industrial symbioses. Energy is a key component of building and construction and therefore, energy solutions of buildings have been discussed within the framework of the construction theme and energy production has been discussed in the water-food-energy sections. The

[5] https://kiertotaloudenvarsinaissuomi.fi/tiekartta-kiertotalouteen/ on 25 February 2019

[6] Green Circular Cities Coalition Concept (2018) ICLEI, 5-6

recycling of textiles, which can be part of industrial symbiosis, has been discussed under the municipal resource management theme, as it becomes regionally highlighted through actors in waste management and projects. The water-food-energy theme includes interesting industrial symbioses and research symbioses.

The analysis section of this report includes preliminary recommendations regarding potential areas where collaboration in the ICLEI network might have significance for advancing circular economy in the Turku region.

General study observations

The study was conducted using public sources and interviews with key persons. 35 key person interviews were realised. The following issues were discussed: their own actions related to circular economy, collaboration partners in circular economy, other experts of circular economy and the challenges and realistic opportunities for the Turku region in terms of advancing circular economy in the next 10 years.

In the framework of this feasibility study, approximately 700 experts of circular economy were identified. They can be grouped as follows:

- Approximately 35 City of Turku employees, elected officials or city organs
- Approximately 20 City of Turku construction projects and other construction projects
- 7 directors of economic development in the Turku region
- Approximately 150 actors related to research and training
- Approximately 30 regional and national actors
- Approximately 90 projects
- Approximately 20 networks
- Approximately 30 strategic entities of the City of Turku and their employees
- Approximately 270 businesses

The actors have been compiled into a list that includes the actor itself, contact person and his/her contact details, interest in the operation of the GCCC network on the part of interviewees, ICLEI theme sectors, a link to home page and a written specification concerning the circular economy operation of the actor. This tool may be used for a more detailed analysis of the data, but it cannot be made public, handed over or presented due to data protection legislation.

On the part of public actors, the mapping has good coverage and the most relevant functions of circular economy in the Turku region have been included in this study. This study is intentionally wide, meaning that the results provide a comprehensive overview and a framework for circular economy operation but will not go deep into details on the part of actors. As a result, circular economy actors are needed in person to reflect on practical measures and their feasibility within the framework of ICLEI collaboration. In more detailed conversations, they will be able to provide the most feasible ideas regarding what Turku could at best give in the ICLEI network collaboration.

As for businesses, businesses that visibly implement circular economy or are cooperation partners of public actors have been taken into consideration in the study. Not all businesses are located in Turku but they operate in the Turku region or in the area of Southwest Finland. It is practical to select businesses for ICLEI cooperation through such public actors that have the best insights into operations of suitable businesses.

URBAN SPATIAL PLANNING AND GOVERNANCE

"Urban spatial planning and governance – Mapping urban metabolism with cities' spatial planning to identify potentials and opportunities in the system and reflecting the results on local policies and decisions."[7]

Circular economy in urban spatial planning in the City of Turku

In the City of Turku, urban spatial planning includes the following areas where circular economy solutions have a key role; city planning and master planning, transport and street planning as well as green area planning[8].

The master plan is a general plan for city land use. It steers the principles of desirable development. The master plan of Turku that is under preparation directs growth mainly to the centre and on the side of main routes[9], thus reinforcing accessibility of public transport and denser construction in accordance with circular economy.

In the City of Turku's land use planning, circular solutions are clearly visible in developing areas where land use is transforming. One area currently highlighted in Turku is a brownfield site – an old industrial area around the city centre consisting of the shipyard, the Port of Turku and the areas of Ratapiha and Itäharju where challenges of circular economy particularly include treatment of land masses, contaminated soil and the potential new uses for these. Structural model work and MAL planning concerning land use,

[7] Green Circular Cities Coalition Concept (2018) ICLEI, 3

[8] https://www.turku.fi/asuminen-ja-ymparisto/kaupunkisuunnittelu on 19 February 2019

[9] Turkuposti 1/2019, 15

housing and transport involve planning of the entire urban area, growth and locating growth in a way that supports the development of public transport in the entire region.[10]

The city plan outlines the prerequisites for construction either on residential area level or on plot level. It determines the intended use of land, building rights, heights of buildings, construction materials, protection values of buildings and nature, and placement of green areas. From the perspective of circular economy, important objects in city planning have included the Linnanfältti area with wooden blocks of flats and, the Skanssi area. In Linnanfältti, the construction material was pre-defined in order to advance wood construction. The Skanssi area has been constructed in accordance with principles of circular economy, platform economy and communality. By making use of building heights and infill construction, it is possible to condense the urban structure. Infill construction is currently being planned in many locations in the city centre, such as in the surroundings of Auriga, Puutarhakatu, Ajurinkatu and Österblad.[11] The new uses for buildings can also be considered part of circular economy. In accordance with the principles of circular economy, life cycle thinking and life cycle costing concerning buildings are important themes in urban spatial planning. In functions that may have an impact on the environment, the city has a crucial role through the environmental permit process. Such functions include, for instance, transfer of soil, functions that affect water areas, different industrial plants and production plants[12].

According to Director of Urban Planning Timo Hintsanen, circular economy is an important and reinforcing part of urban spatial planning in the City of Turku. Having the circular economy mindset permeate all functions in the organization is crucial. The objective is that in ten years, it will no longer be necessary to bring up circular economy separately as it will be self-evident that existing resources and their material recovery should be considered in advance. We could form a principle that if fixing or modifying an existing building is not more expensive than building a new one, renewal will be preferred over new construction.[13]

Transportation and street planning are part of urban spatial planning. Issues that become highlighted in transportation and street planning include taking more environmentally friendly forms of energy into use, increasing the use of public transport and enabling different sharing platforms. A sharing platform of city bikes has been implemented by Turku Region Public Transport Föli, and several private actors offer sharing platforms for renting private cars. A sharing platform of privately-owned parking lots could at some point become a potential addition to existing parking arrangements in the city[14].

Three spearhead projects of the City of Turku, Development of the City Centre, Turku Science Park and Smart & Wise Turku, on their part also support the objectives of Turku in circular economy and carbon neutrality. Through plans of the One Hour Train and tramway, the spearhead projects Development of the City Centre and Turku Science Park combine city attractiveness and improving competitiveness with transportation planning and development that follow the principles of circular economy.[15] The Smart and Wise spearhead project combines themes of urban spatial planning with use of data, striving towards better use of resources.

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[10] Based on material gathered during interviews

[11] Turkuposti 1/2019, 16–17

[12] https://www.ymparisto.fi/fi-FI/Asiointi_luvat_ja_ymparistovaikutusten_arviointi/Luvat_ilmoitukset_ja_rekisterointi/Ymparistolupa/Tarvitaanko_lupa, on 14 March 2019

[13] Based on material gathered during interviews

[14] Based on material gathered during interviews

[15] https://www.turku.fi/keskustavisio, https://www.turku.fi/turuntiedepuisto on 19 February 2019

Smart and Wise is an umbrella project in the framework of which circular economy themes are implemented as follows:

1. The focus area of customerships and service management involves enhancing the supply of services offered by the city. A management model is employed to monitor the feasibility of services throughout their life cycle[16].
2. The focus area of urban spatial planning involves creating a model of anticipatory urban planning based on demographic development and city modelling[17].
3. The focus area of transport and mobility involves promoting the use of environmentally friendly means of transport and public transport, developing electric transport, shared use services and mobility as a service model[18].

Green area planning is part of city planning. Themes related to circular economy in green areas include, for instance, the ability of plants to improve air quality and make urban areas more comfortable. Pleasant green areas are an important motivating factor in everyday mobility by foot or bike. Green area construction is also a target for recycling land masses. Moreover, green areas function in an important role in the treatment and steering of stormwater i.e. rain water and meltwater. In land use planning, a blue-green factor has been employed which is the ratio between plot area and green area.

The Land Use and Building Act is currently being modified. Updating of the master plan began ten years ago and the goal for completion is year 2029. The preliminary policy is that development work will become more continuous after the master plan 2020 and that a thematic development model will be adopted.

Key projects within the theme of urban spatial planning in the Turku region

- The objective of the Northern Growth Zone is to reinforce the attractiveness of Finland as an operational environment for business through sustainable development of mobility and logistics.
- City of Turku areas under planning or land use planning, such as the development of Linnakaupunki area, Skanssi, Itäharju and the VR engineering workshop area.
- The theme of the BSR Electric project is e-mobility solutions in cities around the Baltic Sea area.
- The Open innovation platforms spearhead project, where the theme of partial implementation in Turku was urban spatial planning in the Skanssi area.
- The Green-in-Turku research project studies innovative ways of using green areas in urban spatial planning to create a more comfortable environment.
- The objective of the Canemure project is to advance smart low-carbon mobility, to increase production of dispersed renewable energy, to improve the energy efficiency of buildings and to create processes that support prerequisites of low-carbon production and consumption.

[16] https://www.turku.fi/asiakkuuksien-ja-palvelujen-hallinta on 19 February 2019

[17] https://www.turku.fi/kaupunkisuunnittelu-0 on 19 February 2019

[18] https://www.turku.fi/liikenne-ja-liikkuminen on 19 February 2019

- The objective of the SeBNet – Smart Electric Bus Network Integration project is to develop solutions to integrate the production of renewable energy into electronic public transport. Another objective of the project is implementing a smart hub of electrical transport.

Challenges and future opportunities of circular economy in urban spatial planning in the City of Turku

In the interviews conducted for the study, some challenges related to urban spatial planning were identified[19]. Urban spatial planning is a long-term activity where solutions have long-term impacts. The solutions of today are largely made in an environment that is already entirely or partially filled with solutions that have been made over previous decades. Existing structures guide and often set limitations to the creation of new plans. Assessing the life cycle of the entire plan is difficult at the time of planning, because future needs cannot be estimated with absolute certainty.

When creating a plan, it must be taken into consideration that implementation of the plan provisions should be possible for actors already in the market or for those about to enter the market. One example is the construction of wooden blocks of flats in the Linnanfältti area. The process took longer than expected because it was not possible to find suitable actors to implement the city plan provisions. As the location of Linnanfältti is interesting and the city held strong views on wood construction in the area, suitable developers were ultimately found in businesses, wood industry, construction industry as well as the City of Turku building control. In the case of Linnanfältti, land use planning functioned as an engine of circular economy after initial challenges, advancing the development of wood construction.[20]

Transportation solutions have a key role in reaching carbon neutrality but replacing private motoring with comprehensible public transport is neither possible nor cost-effective. Private motoring is also a matter of culture and habit, and an improved network of public transport or accessibility may not necessarily change how city residents operate.

In the interviews conducted for the study, the following opportunities related to urban spatial planning were identified. In these areas, progress can be made in the Turku region over the next decade[21]:

1) Site development areas such as Tiedepuisto, Ratapiha, Blue Industry Park and Itäharju could become examples of circular solutions.
2) Creating an urban, people-gathering circular economy platform/district that could be realised e.g. in Itäharju.
3) The City of Turku could provide locations for platforms and support for entrepreneurs with developing platforms.
4) Opening pop-up spaces and enabling flexible use of already existing spaces for different purposes.
5) Developing transport and mobility in the city. The city could enable and support the use of car sharing to complement public transport.
6) Using anticipatory urban spatial planning in planning the use of building stock and cycle.

[19] Based on material gathered during interviews

[20] Based on material gathered during interviews

[21] Based on material gathered during interviews

7) Developing the municipal structure in order to advance carbon neutrality in mobility and energy solutions.
8) The proximity and optimal coverage of services.

Description of the City of Turku administrative structure

Another area of this ICLEI theme sector is city administration, the decisions of which are key in advancing circular economy. The highest authority in the City of Turku is exercised by the elected City Council with 67 city councillors. The current council term is 2017–2021[22]. City officials prepare proposals for committees, who either make the decisions on their own or take the proposals onward to the City Board[23].

Picture 2. *In the City of Turku administration, several actors in various roles either advance or have opportunities to advance objectives of circular economy.*

[22] http://www.turku.fi/kaupunginvaltuusto on 19 February 2019

[23] https://www.turku.fi/paatoksenteko on 21 February 2019

Actors in the City of Turku who have a key role in advancing circular economy include

1) City employees in charge of, for instance, urban spatial planning, construction, building control and public procurements.
2) City employees who actively engage in projects related to environmental protection, climate issues and circular economy
3) The following committees: Urban Environment Committee, Building and Permit Committee, South-west Finland Waste Management Committee and potentially the Education Committee.
4) The City Development Section of the City Board. This section is responsible for the strategic steering of the city's land use, use of space and property development.
5) The Concern Section of the City Board. This section is responsible for corporate governance and monitoring of Turku City Group's subsidiaries
6) Mayor
7) City Council
8) City residents

Advancing climate issues and circular economy in City of Turku administration

On 11 June 2018, the Turku City Council approved the climate plan which sets carbon neutrality by 2029 as the main goal of climate policy. The climate plan includes detailed descriptions of actions towards implementing this goal. These include, among others, a carbon neutral energy system, low-carbon sustainable mobility, sustainable urban structure, climate responsibility of Turku City Group, reinforcing carbon sinks, and SECAP cards that contain climate measures from different actors[24]. Their implementation will involve circular solutions.

Over the last few years, there has been more awareness and solution-oriented approaches in the City of Turku in terms of setting the environment in a more significant role in decision-making. However, economically feasible solutions are still required for many concrete actions for them to be put into practice[25].

Involvement of city residents means close collaboration between residents, officials and persons that prepare matters. Involvement in Turku has been divided into decision-making involvement, planning involvement and activity involvement.[26] An example of planning involvement is Turku Future Forums, where themes related to urban spatial planning and mobility have been discussed in connection with circular economy.

In decision-making, customer-based panels represent the perspective of service users. Citizen volunteer activities offer an opportunity for residents to improve their immediate surroundings. It is possible to participate and have an impact also on social media.

[24] Climate Plan 2029, the City of Turku Sustainable Energy and Climate Action Plan, Turku City Council on 11 June 2018 § 142 9-15

[25] Based on material gathered during interviews

[26] https://www.turku.fi/osallisuus-turussa-monta-tapaa-vaikuttaa on 25 February 2019

Key projects within the theme of city governance in the Turku region

- Skanssi co-developing forum induces involvement of residents and businesses and dialogue with them for building a smart and environmentally neutral residential area.
- The Citizens' energy transition project where themes include involving city residents, businesses and communities and creating encouraging ways for them to take part in the implementation of the City of Turku climate goals.
- The Eurocities network, in the environment forum of which Turku takes part, highlights the importance of local administration in decision-making at different levels
- The goal of the Nutrient Neutral Municipality project is to have the municipality engage actively in nutrient recycling.

Challenges and future opportunities of circular economy in City of Turku administration

In the interviews conducted for the study, some challenges related to city governance were identified.[27] One of the most significant challenges was that resources are limited in relation to the need for reform implementation. Another significant challenge is providing the actor level with concrete operational guidelines. If we want to attain a carbon neutral Turku by 2029, it is essential to put effort into circular economy. At the same time, solutions of circular economy need to be developed further. Some solution proposals for advancing the use of circular economy products include legislative changes but these are not issues that can be decided by city administration.

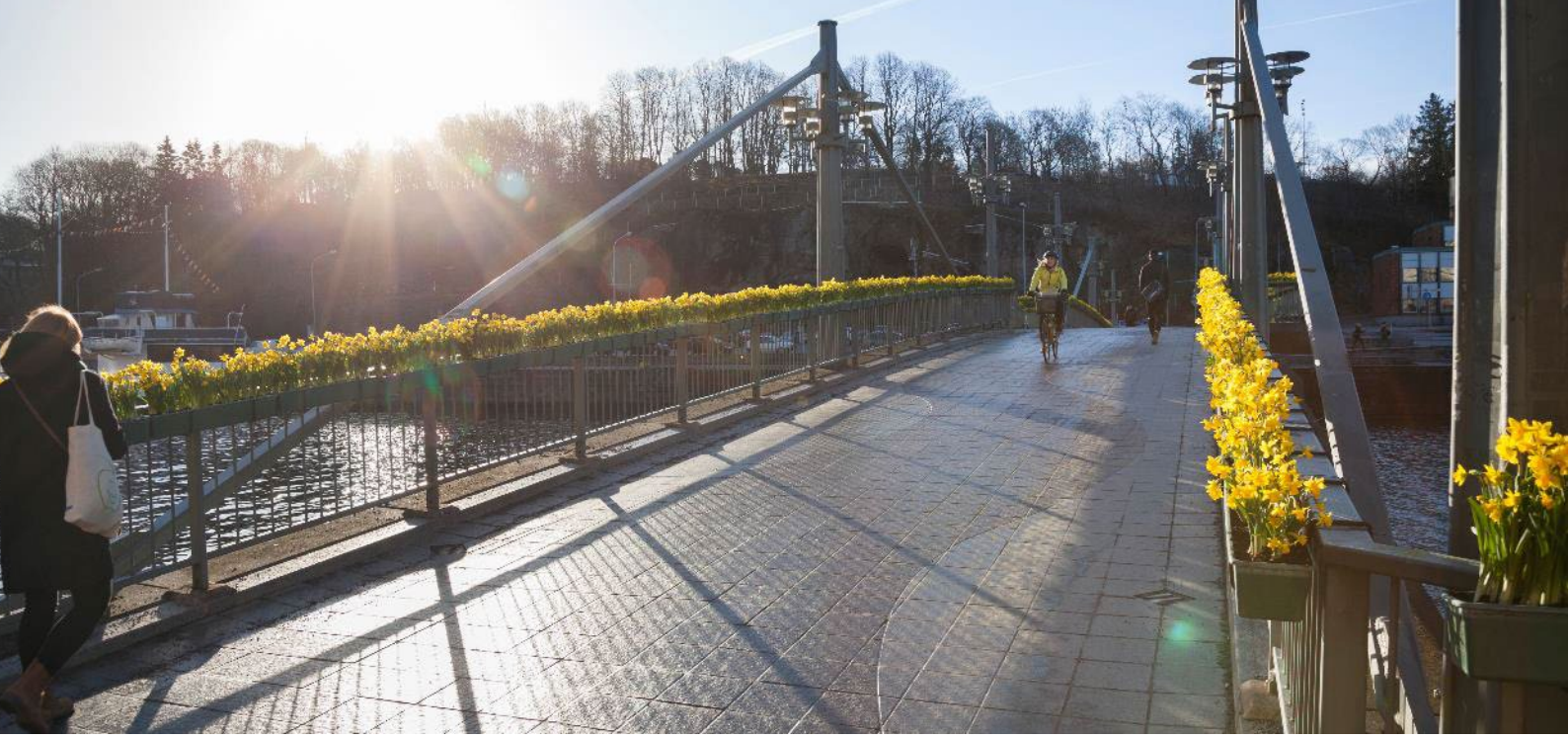
In the interviews conducted for the study, the following opportunities related to city governance were identified. In these areas, progress can be made in the Turku region over the next decade[28]:

1) Through slightly better resourcing, much could be done to advance environmental affairs. The potential benefit massively outweighs the effort.
2) Carrying out optimisation, examining how to obtain the best benefit with existing resources.
3) Expanding eco-support activity. In eco-support activity, people have been trained to make resource wise decisions. The concept is well-functioning and motivates individuals to think outside the box.
4) The city could create opportunities for circular economy operations of businesses.
5) Creating shared operational objectives and models.
6) Acknowledging and understanding the interface between the City of Turku and businesses.
7) Creating new collaboration partnerships through regional actors and opportunities.
8) Giving tax concessions or economic incentives to businesses that use recycled material in their products would create and support markets for recycled materials.

[27] Based on material gathered during interviews

[28] Based on material gathered during interviews

9) Supporting the products as a service concept through legislation would enable material to remain under the control of the producer. This way, the material would also return into circulation as efficient circular economy chain.
10) Involving businesses and communities, development partners and higher education institutions in creating climate actions and building a carbon neutral Turku.
11) Reinforcing communications and flow of information. Circular economy requires publicity.
12) Reinforcing climate responsibility within city administration and organization. Increasing understanding of climate change risks and measures to prepare for climate change.



CIRCULAR PUBLIC PROCUREMENT AND SUPPLY CHAIN

"Circular public procurement and green supply chain – Mainstreaming the circular enablers through public procurement to close the material loops based on ICLEI's intensive experience in Green Public Procurement and Procura+ Network."

The public sector procures goods and services annually for approximately 35 billion euros, which is around 17% of the GDP[29]. Procurements in the public sector mainly involve large units and longer contracts and this makes them interesting for businesses. This gives procurers in the public sector the leverage to advance matters they consider important through procurements. The public sector is a strong influencer and sets an example in procurement.

Realisation of circular economy in City of Turku procurements

In terms of climate responsibility of Turku City Group, the climate plan states the following:

"From 2019 onwards, Turku City Group's subsidiaries will be obliged to focus on the impacts on climate, environment and life cycle of their investments and acquisitions."

"In investments and acquisitions, circular economy solutions will be promoted, and consumption of natural resources will be reduced" and

"Impacts on climate, environment and life cycle will be emphasised in acquisitions as efficiently

[29] https://www.motiva.fi/julkinen_sektori/kestavat_julkiset_hankinnat on 20 February 2019

as possible from 2019 onwards. Sufficient resources will be allocated for this and expertise will be created in collaboration."[30]

Turku City Group has approximately 60 subsidiaries where the city of Turku has dominant influence. Turku City Group also has a significant number of joint ventures, where the shareholding of the City of Turku is 20–50%. The most important of these have been named as the City's strategic entities in the areas of housing and real estate business, economy and competence business, energy and infrastructure business, tourism and cultural business and production business[31]. The City of Turku makes a significant share of its procurements from companies where it has influence or dominant influence. This will advance adopting circular solutions in such companies and in procurements because, in accordance with the climate plan, Turku City Group companies have the obligation to focus on the impacts on climate, environment and life cycle in their operations from 2019 onwards.

Some of the businesses which are part of Turku City Group have been frontrunners for years in developing circular economy solutions and in applying them. Turku Science Park Oy actively collaborates with companies under its spearhead field of cleantech in the development of circular economy. Turku Energia Oy develops lower-carbon energy production methods for heating and strives to acquire electricity from renewable sources. Lounais-Suomen Jätehuolto Oy is responsible for regional municipal waste management and actively develops practical circular economy and using waste as a resource. Turun Seudun Vesihuolto Oy and Turun Seudun Puhdistamo Oy collaboratively manage the collection and treatment of waste water using the operating model of circular economy. The Student Village Foundation of Turku has been implementing circular economy in renewable energy production and sharing in student apartments.

The City of Turku also makes procurements from outside Turku City Group. Circular economy is progressively being taken into consideration in the strategic procurements of the city. However, it has been challenging because there is not enough information available on the products involved in tendering to assess their environmental footprint. To facilitate this, a sustainable procurement guide is being prepared, based on guidelines of Motiva and Swedish sources. The guide will be completed by summer 2019 and it will include instructions for small-scale procurement. The objective of the guide is that the party inviting tenders does not need to set any sustainable development criteria, as these would be set in a procurement meeting instead[32].

The City of Turku investments

In addition to public procurements, the City of Turku carries out investments, mainly in renovation building, in new construction and in infrastructure of new residential areas. For the financial plan period 2018–2021, investments amounted to approximately 350 million euros.[33] on 28 January 2019, Turku signed a Turku Urban Infrastructure financing agreement worth 150 million euros with the European Investment Bank EIB

[30] Climate Plan 2029, the City of Turku Sustainable Energy and Climate Action Plan 2029, Turku City Council on 11 June 2018 § 142, 13

[31] https://www.turku.fi/organisaatio/konsernin-yhtiot-ja-yhteisot on 20 February 2019

[32] Based on material gathered during interviews

[33] The City of Turku action plan, the budget for 2018 and the financial plan for years 2018-2021, Turku City Council on 13 November 2017, 3

to make the investments. Energy efficiency and climate impacts were key criteria in the realisation of funding,[34] which demonstrates that the pressure to highlight climate viewpoints already comes strongly from investors.

Key projects within the theme of public procurement in the Turku region

- In the focus area of carbon neutrality and resource wisdom of the Smart & Wise Turku spearhead project, a model will be taken into use for assessing life cycle impacts in investments and public procurements made by the City of Turku[35].
- Themes of the RANKU – Nutrient Neutral Municipality project include the opportunity of municipalities to have an impact through procurement and procurement criteria.
- The City of Turku uses an electronic recycling system for furniture.
- The project C2 Circwaste advances resource efficient public procurements through the circular economy service centre that serves both public and private actors, assisting with utilisation of circular economy objectives and criteria in public procurements.
- The partial implementation of the Open innovation platforms in Turku is developing innovative procurement.
- Public procurements have an important role as a cross-cutting theme in in the regional roadmap of Southwest Finland.

Challenges and future opportunities of circular economy in City of Turku procurements

In the interviews conducted for the study, some challenges related to public procurements were identified[36]: Taking circular economy into consideration in procurements has been challenging because of the lack of information on the environmental footprint of different products and services. For the same reason, creating criteria has been challenging. Another challenge for procurements is the fact that the Act on Public Procurements is extremely detailed, raising caution towards procurement. In the framework of the Act on Public Procurements, the criteria for procurements must be determined beforehand in detail. Often procurers are not able to obtain information from companies on time before tendering regarding the most recent approaches. Therefore, putting new innovations out to tender is impossible. Different aspects can be put out to tender and given scores, e.g. quality and price. However, the criteria cannot excessively limit competition or favour any actor. In addition, regardless of how quality criteria have been determined, the price must be reasonable.

[34] https://www.kauppalehti.fi/lehdistotiedotteet/turun-kaupunki-turun-kaupunki-ja-euroopan-investointipankki-sopivat-150-miljoonan-euron-rahoitussopimuksen/f5433f05-098e-3883-a796-7b57787c2cbd, on 21 February 2019

[35] https://www.turku.fi/hiilineutraalius-ja-resurssiviisaus on 19 February 2019

[36] Based on material gathered during interviews

Competitive tendering only refers to the part of the process where the resources available for different items are set out. Before selecting tendering criteria, the attainable benefit must be determined. It would be important to model things, but this requires coordination. The advancement of circular economy is also slowed down by the fact that products or services in accordance with circular economy may not be on the market yet but instead they may remain on a conceptual or experiment level. It should be possible for businesses to meet procurement criteria – they cannot be overly challenging. A legislative change is needed for procurements, as public procurements ought to have clear criteria regarding the amount of recycled material or recycling solutions[37]. Carbon footprint calculation could advance the consideration of climate issues in public procurement, but progress in this area is currently delayed significantly because development and standardisation of measuring methods take time. A monitoring system for maintaining and measuring commitments is also needed to make the climate impact of procurements more transparent. The tendering process is too heavy for smaller businesses, which is why they are seldom able to offer their products. The City of Turku has had conversations with Varsinais-Suomen yrittäjien ja pienyritysten liitto (the interest and service organization for entrepreneurs and small enterprises in Southwest Finland) regarding how the ability of small businesses to offer their products could be improved.

In the interviews conducted for the study, the following opportunities related to public procurements were identified. In these areas, progress can be made in the Turku region over the next decade[38]:

- Carbon footprint calculation as the basis of public procurements, international politics and legislation. As part of ICLEI collaboration, Turku could pilot carbon footprint in its public procurements, promote it and spread experiences in the ICLEI network. Food, for instance, could be an interesting subject area.
- The centralisation of procurement collaboration between municipalities and the state as KL-Kuntahankinnat and Hansel merge may open new opportunities for advancing circular economy through more centralised competitive tendering. Turku also has a regional joint procurement ring with neighbouring municipalities.
- The Association of Finnish Local and Regional Authorities could begin to actively demand such reforms in the Act on Public Contracts and competition law that would be needed to take climate criteria into consideration in procurements.
- There are opportunities for advancing circular economy, as city procurements amount to over 500 million euros per year plus investments.
- Electric taxis now have a half-minute advantage over other taxis to take the passenger, after which the passenger can be taken by any taxi. In accordance with this example, benefits could be offered to actors who have taken ecology into use.
- Objective assessment is needed, assessments made by a third party are adequate to steer procurements.
- The prominent role of actors in the public sector as forerunners in circular economy. More prominent inclusion of quality criteria in conditions of tendering.

[37] Based on material gathered during interviews

[38] Based on material gathered during interviews

CIRCULAR INDUSTRIAL PARK (INDUSTRIAL SYMBIOSIS)

"Circular Industrial park (industrial symbiosis) – Enhancing the collaboration between individual companies on resource and by-products exchange with the consideration of geographical proximity."

From the perspective of this study, industrial symbioses cover both industrial and research symbioses as well as operation intended to develop the activities of circular economy businesses. Of the different fields, construction, energy production and water and food industry along with related research have been discussed in the ICLEI themes.

Realisation of circular economy in industrial symbioses in the Turku region

Based on this study, circular economy has been understood as a broad term that, particularly in the business sector, loosely describes operating models and solutions that save resources. Circular economy includes, among others, bio economy, that covers for example, forest industry, chemical industry, pharmaceutical industry, food industry, fishery and agriculture[39]. In bio economy, materials are nature-based and renewable. This creates a strong link between bio economy and circular economy. Not all bio economy is necessarily circular economy that requires effective and comprehensive use of nature materials and returning them into circulation. However, in all bio economy, there are opportunities and potential for developing circular economy solutions.

[39] https://www.sitra.fi/aiheet/biotalous/#mista-on-kyse, on 21 February 2019

The focus areas of businesses in the Turku region include bio industries, ICT industries, maritime industry, metal industry, construction, logistics and creative industries[40]. As for bio economy, Turku region is abundant in chemical industry, pharmaceutical industry, agriculture and food production as well as businesses representing these sectors that implement circular economy at least to some extent. There are also many businesses in the Turku region that identify themselves as cleantech i.e. clean technology businesses. These businesses develop and produce technologies, processes, products and services that advance sustainable use of natural resources and reduce negative environmental impacts of business.[41]

Large businesses are very aware of circular economy and it often already forms a part of their strategy. Industry and businesses have for a long time been looking for circular economy solutions. Effective production includes circular economy thinking, even though it is not always seen in businesses primarily as a pro-environment act but rather as cost-efficiency.[42] Smaller businesses have less resources to implement circular economy in their operation and production. Therefore, such actors tend to need more information to implement circular economy[43]. On the other hand, some of the smaller businesses have been established in order to implement circular economy, which demonstrates the ability of circular economy to create new opportunities for employment. Large companies can act as forerunners of circular economy by extending their resources to their partner and sub-contractor network and by promoting development of circular economy solutions.

There are 22,000 businesses in the Turku region[44]. Actors that bring businesses together include, for instance, Varsinais-Suomen Yrittäjät, (organization for entrepreneurs in Southwest Finland) Turku Chamber of Commerce, Technology Industries of Finland, the Confederation of Finnish Construction Industries, the Chemical Industry Federation of Finland, the Turku City Centre Association and the Finnish Forest Centre. In addition, local directors of economic development /local agents are a potential link for reaching businesses if the objective is to map out or advance industrial symbioses of businesses. In the framework of this study, 300 such businesses have been mapped out in the Turku region that implement circular economy activities in one way or another. The number of businesses implementing circular economy is much higher but mapping out these businesses is neither possible nor necessary in the framework of this study. The businesses appearing in this study have either been identified based on public circular economy operation or they are partners of such public actors involved in circular economy projects that have come up in the context of interviews.

[40] http://turunseutu.fi/bt/fi/cms.nsf/pages/A7FDEC9740E72DB0C2257C2A004036E9?opendocument on 21 February 2019

[41] https://www.sitra.fi/artikkelit/mita-nama-kasitteet-tarkoittavat/ on 21 February 2019

[42] Based on material gathered during interviews

[43] Based on material gathered during interviews

[44] http://turunseutu.fi/bt/fi/cms.nsf/pages/A7FDEC9740E72DB0C2257C2A004036E9?opendocument on 21 February 2019

Research in the Turku region advancing circular economy

Thriving research in the Turku region forms a solid foundation for the dominant fields of businesses in the area and for their circular economy activities. Research in the area of advancing circular economy is conducted particularly by the University of Turku and Åbo Akademi. In the field of biochemistry, the University of Turku conducts research in biochemistry, biotechnology, food chemistry and food development as well as molecular plant biology. In the field of chemistry, strong areas of research include bio-organic chemistry, detection technologies, inorganic material chemistry, natural compound chemistry and materials chemistry. At the Åbo Akademi Process Chemistry Centre, research is conducted in both organic and inorganic chemistry. High temperature chemistry and combustion processes are areas of special expertise in the process chemistry centre.[45] In the Raasepori and Vaasa units of Novia University of Applied Sciences, research is conducted in bio economy and sustainable energy economy. In addition, research related to the marine industry and maritime investigation is carried out extensively at the University of Turku, in Åbo Akademi and in the Turku-based unit of Novia. The strategic focus point of these studies is not in circular economy, but they have links to circular economy. In research groups of Turku University of Applied Sciences, the focus is on circular economy business models, platforms of value creation, built environment, product process of the future, new energy as well as water technology and environmental technology, all of which have links to circular economy.

Key actors advancing circular economy in businesses in the Turku region

Turku Science Park Oy, a strategic entity of the City of Turku, is a forerunner and enabler in the sector of industrial symbioses in the Turku region. It is a strong participant in innovation activities of businesses through co-creation and has a business network involving hundreds of companies in the spearhead fields of Clean and Health. One prominent example is Smart Chemistry Park – a cluster of businesses in the field of chemistry. Located in Raisio, Smart Chemistry Park offers a wide range of expert services related to circular economy and works in collaboration with businesses in the area, advancing circular economy solutions. Through the spearhead field of Maritime, Turku Science Park Oy participates in the implementation of Blue Industry Park, a resource wise and carbon neutral business park that is built in the nearby Turku shipyard in several phases between 2019 and 2030[46].

Turku University of Applied Sciences actively engages in circular economy projects and education projects in collaboration with businesses.[47] It has dozens of collaboration companies every year. Bastu is a network of businesses initiated by the University of Turku that advances resource-scarce sixth-wave business operations. The network covers more than 200 actors consisting of businesses and experts. CLIC Innovation is an open innovation cluster linking higher education institutions, research institutes and large

[45] Based on material gathered during interviews

[46] https://turkubusinessregion.com/palvelut/kasvu-ja-kehittaminen/meri-ja-valmistava-teollisuus/ on 21 February 2019

[47] Based on material gathered during interviews

companies in development of bio economy, energy and cleantech. The Egreennet network of environmental know-how takes part in creating more business opportunities of circular economy for companies and Green Know-how Turku advances collaboration between companies, educational institutions and actors in the public sector. Public units developing circular economy in collaboration with businesses in the Turku region include the City of Turku, Valonia, the Regional Council of Southwest Finland, Lounais-Suomen Jätehuolto, Topinpuisto, Turku University of Applied Sciences, Åbo Akademi, Smart Chemistry Park, Turku Science Park Oy, the University of Turku/Bastu, Union of the Baltic Cities and the ELY Centre for Southwest Finland (Centre for Economic Development, Transport and the Environment).

Key projects within the theme of industrial symbioses in the Turku region

- The partial implementation of the Carbon Neutral and Resource Wise Industrial Areas project (ERDF, Six City Strategy), including several project partners from Turku, involves planning Blue Industry Park business area functions where circular economy will have a significant role
- CICAT2025 is a research project focused on innovation ecosystems. The project finds solutions for businesses and decision-makers when transitioning to circular economy.
- In the FISS Varsinais-Suomi project, businesses formed industrial symbioses. A database including actors in circular economy was also completed in the project.
- Foodtech Platform Finland brings together food industry businesses and technology businesses to develop new solutions for advancing competitiveness in these fields.
- The Biopen project brings European bio economy clusters together, with the objective of finding new collaboration opportunities for businesses in the bio economy sector.
- Sustainability and Transparency in Shipbuilding networks is a research project related to shipbuilding and sustainable development.
- The 6Aika project Circular Economy Centres of the Future advances business opportunities developing around circular economy.

Challenges and future opportunities of circular economy in industrial symbioses

In the interviews conducted for the study, some challenges related to industrial symbioses were identified.[48] Industrial processes are difficult and expensive, and investments are needed to set up operation. Many waste flows are insufficient and uncertain for high-volume production, because the availability of fractions of waste needs to be secured for long term in order to justify investments made in production. Many side streams are suitable for small companies but accordingly, the environmental impact is less significant.

[48] Based on material gathered during interviews

A challenge for research collaboration is that businesses have a prominent interest in clear investment projects or strong research projects whereas higher education institutions are more interested in developing a theme. The front end of the circular economy chain starting from the planning phase requires more attention.

The lack of experts is one of the potential challenges of the future. Practically all technical higher education institutions offer studies based on which one may become employed in circular economy functions. However, understanding circular economy and finding solutions requires multidisciplinary input and multi-level thinking. The supply of analytics offered to industry in Finland has decreased. This might mean that businesses will not be able to find expert services even if they were interested in developing circular economy solutions. An overall experience is that while there are many opportunities on the business field of circular economy, there are too few actors who are both competent and ready for action. "We need people who can put things together, people who have a good understanding of the process and are ready see it through."[49]

For the ICLEI international collaboration network, industrial symbiosis represents a challenging theme because it is difficult to obtain information on the operation of businesses. Due to General Data Protection Regulation, GDPR, obtaining information on businesses with circular economy activities is challenging. Business secret also prevents access to concrete information. One's business model is understandably part of the competitive advantage of the business and therefore there is rarely will to make it public. Information on circular economy activities found on the sites of businesses is often vague. In spring 2019, the ELY Centre conducts a questionnaire survey for 200 businesses in the regions of Southwest Finland and Satakunta regarding their views on circular economy. The findings may be of interest even for a deeper understanding of this thematic sector.

In the interviews conducted for the study, the following opportunities related to industrial symbioses were identified. In these areas, progress can be made in the Turku region over the next decade[50] :

1) Shipbuilding is an interesting and significant field in the Turku region from the perspective of advancing circular economy.
2) Optimisation of business transports and logistics.
3) There are many well-functioning components that should be combined to create realistic solutions.
4) Advancing service economy.
5) Increasing bio-based solutions.
6) Raising awareness in companies. Every business and sector should understand that circular economy is the new paradigm that is relevant to everyone.
7) Small and medium-sized enterprises need inspiring examples of their own size on how circular economy can work. There are very few actual cases in public – more media visibility would be necessary.
8) Turku has all the potential to thrive in circular economy. In addition to a city vision, we need an industrial vision that systemically involves businesses in circular economy.

[49] Based on material gathered during interviews

[50] Based on material gathered during interviews

MUNICIPAL RESOURCE MANAGEMENT

"Municipal Resource Management – Identifying municipal waste streams, minimizing the generation of waste, transforming waste into resources, and maximizing the demand for secondary materials within cities and regions"

Often circular economy is perceived through waste recycling and recovered materials. These are very important areas of circular economy because the traditional linear economic model has focused on replacing an old product with a new one. It is a principle of circular economy that, right from the start, products are designed to be fixable, reusable and easily recyclable. Presently, products that are reaching the end of their life cycle have not usually been designed using circular economy principles. Therefore, a lot of work has been done in waste management to develop recycling. Circular economy is also a strong theme in the national waste plan to 2023 "From Recycling to a Circular Economy". Its most important objectives by year 2030 are related to implementation of sustainable circular economy, material efficient production, reduction of waste, well-functioning recycling markets, harmless material cycles, high-quality research and experimentation in the waste management sector. For municipal waste, the recycling target is 55% and for bio waste the target is 60%.[51]

[51] http://urn.fi/URN:ISBN:978-952-11-4774-6 21.2.2019

Realisation of circular economy in waste management in the Turku region

Lounais-Suomen Jätehuolto Oy is a company owned by 17 municipalities. On behalf of these municipalities, it is responsible for advice on waste and for organising waste management. The City of Turku owns 23% of the company. The operation of the company is steered by the Southwest Finland Waste Management Committee and the waste management policy programme.[52] Currently, approximately 1–2% of waste in the Turku region ends up in landfill sites.[53] Recyclable waste is recycled and the rest is used as energy.[54] The energy use of waste currently takes place outside the area but an eco-power plant will be completed in Salo by 2021. There, non-recyclable municipal waste will be turned into local energy[55]. Lounais-Suomen Jätehuolto has 12 waste treatment centres and sorting stations where residents can bring different types of waste for recycling. Recyclable items include bio waste, ceramic dishes, plasterboards, wood waste, bitumen roofing felt, flat glass and windows with frames, hazardous waste, impregnated wood, electrical and electronic waste, twigs, raking waste, glass packaging, metal, waste paper, cardboard packaging, plastic packaging, tyres without rims, textile, lamps and vehicle batteries. Some recyclable materials have their own producer communities to whom LSJH delivers the collected fractions of waste.

Topinpuisto is a circular economy centre and collaboration network that has been formed around Topinoja waste treatment centre. Its objective is to develop solutions and business opportunities based on circular economy. Topinpuisto is a platform that enables advancing circular economy and it is also a physical environment where several environment sector businesses operate, developing circular economy together and processing over 60 different material flows.[56] The Topinoja sorting station will be renewed 2019–2020 e.g. by making it easier for the consumer to leave different materials for recycling before they end up as waste. The objective is to implement a solution like Retuna[57], which is a centre of circular economy in Eskilstuna and has attracted around it an ecosystem of businesses that reshape objects left for recycling and sell them to customers. This has attracted customers in the area, developing a vibrant centre of circular economy. Visiting centre Kahmari has been opened in connection with Topinpuisto, allowing visitors to learn about circular economy through examples and exhibitions. The objective is to bring circular economy and circular economy solutions closer to residents and in that way educate them about recycling. Another goal is to compile a material library of over 60 different material flows, also creating a description of them and mapping out their qualities. An information package for small businesses and designers will be created in collaboration with Hub Turku.[58]

In accordance with the European Union waste framework directive, a separate collection for textiles must be arranged by 2025. Textile recycling is a strong theme in the Turku region and in the circular economy activities of Lounais-Suomen Jätehuolto. Several projects related to textile recycling and the

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[52] https://www.lsjh.fi/fi/yritys-ja-ymparisto/lounais-suomen-jatehuolto-oy/ on 21 February 2019

[53] Based on material gathered during interviews

[54] Based on material gathered during interviews

[55] Huomiselle, magazine of Lounais-Suomen Jätehuolto for residents, February 2018, 5

[56] https://www.topinpuisto.fi/info/ on 21 February 2019

[57] https://www.retuna.se/ on 21 February 2019

[58] Based on material gathered during interviews

volume of textile recycling have inspired an idea of extending the collection of waste textile to the whole of Finland and developing high-quality sorting and post-sorting refinement in the Turku region.[59] Telaketju is a collaboration network promoting textile recycling that develops the collection, sorting and further processing of waste textile. It also develops business operating models based on circular economy. Opportunities for getting a refining plant for textile waste in Southwest Finland are currently being investigated. The objective is to have a plant where material flows can be steered to even from areas of neighbouring countries. The planning of a pilot plant is underway, and the goal is to have the plant in operation before the end of the year 2020.[60]

In addition to municipal waste management, also business waste is collected in the Southwest Finland area. Examples of such actors include Lassila & Tikanoja, a company describing itself as a hands-on actor in circular economy, and Remeo, which has its own material handling facility in Kaarina. Producer communities carry out waste collection for specific products such as plastic, deposit bottles and electronic waste.

Key projects within the theme of waste management in the Turku region

- The Circwaste project is a national project promoting circular economy. It aims to advance circular economy particularly through the national waste plan.
- The objective of the CircHubs – Circular Economy Centres of the Future project is to discover new business opportunities in circular economy and to support commercialisation of new ideas.
- The Urban Mining project is focused on advancing the recovery of resource metals from energy waste.

Challenges and future opportunities of circular economy in waste management

In the interviews conducted for the study, some challenges related to municipal waste management were identified[61]. The total amount of waste is still on the rise even though the relative amount is going down. Many phases of successful recycling depend on the activeness and awareness of residents. In part, city residents find sorting of waste so complicated that it is left undone. On the other hand, waste collection points are located quite far for some, which is another reason why sorting of waste may be passed. It is often experiences that all materials should be recycled but the energy use of waste is a positive thing even in case of such waste that is not feasible to recycle for one reason or another. In order to have successful circular economy in waste management, a sufficient volume of collectible fractions of waste is needed. Reaching this goal requires regional collaboration.

[59] Based on material gathered during interviews

[60] Huomiselle, magazine of Lounais-Suomen Jätehuolto for residents, February 2018, 12–13

[61] Based on material gathered during interviews

In the interviews conducted for the study, the following opportunities related to waste management were identified. In these areas, progress can be made in the Turku region over the next decade.[62]

- Textile recycling and further processing of waste textiles.
- Car recycling
- Ship recycling
- Further development of Topinpuisto
- More efficient processing and recycling of packaging materials
- Material recovery of packaging materials (canisters, plastic bottles etc.)
- Waste management regulations can be used to prescribe that collection points should be located closer to consumers (e.g. recycling obligations of housing companies)

[62] Based on material gathered during interviews

BUILDINGS AND CONSTRUCTION

"Buildings and construction – Mainstreaming the circular enablers and life cycle assessment in local governments' building code regulation and synergizing with ICLEI's expertise in Building Efficiency Accelerator and Green Climate Cities to retain the value of building materials as much as possible in the urban system."

Approximately one third of greenhouse gas emissions in Finland is due to use and construction of buildings. This places construction in a key role in attaining climate objectives.[63] Approximately seven billion euros are annually spent in public construction project in Finland. This equals roughly 30 per cent of the total value of public procurements.[64]

This report examines buildings and construction from two viewpoints. Examination related to construction includes construction of new buildings and areas from land use planning until the end of the process. Also, the meaning of circular economy in this process is under examination. Examination related to buildings concerns existing building stock, its maintenance, renewal and ultimately demolition. Together, these areas form a life cycle that the City of Turku increasingly needs to and wants to examine.[65]

[63] http://www.ym.fi/fi-FI/Maankaytto_ja_rakentaminen/Rakentamisen_ohjaus/Vahahiilinen_rakentaminen/Rakennusten_hiilijalanjaljen_arviointime(48507) on 23 February 2019

[64] http://www.ym.fi/fi-FI/Maankaytto_ja_rakentaminen/Rakentamisen_ohjaus/Vahahiilinen_rakentaminen/Oppaat_vahahiiliseen_rakentamiseen on 25 February 2019

[65] Based on material gathered during interviews

Realisation of circular economy in buildings in the Turku region

Essential factors related to circular economy in buildings during use include maintenance and renewal. Maintenance and renewal are needed to extend the service life of buildings. Extending the life cycle of buildings often requires changing their intended purpose. This is easier and more cost-effective if flexibility has been taken into consideration already in the planning phase. New schools and other public buildings in Turku have been planned and constructed in accordance with principles of circular economy, focusing on suitability for multiple purposes. In this way, adaptability will be easier in the future.

The utilisation rate of spaces is also part of circular economy. When spaces are efficiently used, there is less need for new construction. In some buildings, portability is part of circular economy. Log houses have traditionally been moved from one place to another, but also industrial buildings, steel structures and tarpaulin structures can be moved to another place if necessary.[66]

Improving energy efficiency is a concrete act through which circular economy has been implemented in existing building stock. Energy efficiency has been implemented through a voluntary agreement between the state and industries in the 1990's. Savings made at the end of the agreement period 2008–2016 amounted to approximately 16TWh on an annual level. This cuts carbon dioxide emissions by over 4.7 million tons and is equivalent to saved energy costs worth 560 million euros. The City of Turku takes part in the municipal sector energy efficiency agreement 2017–2025.[67]

Realisation of circular economy in construction in the Turku region

One of the basic principles of circular economy is taking into consideration the entire life cycle of the product already in the planning phase. For buildings, construction phase and preceding phases of planning are a crucial time for planning and calculating the life cycle impacts of buildings. Construction and final decisions on circular economy of new buildings are often the responsibility of private building companies. However, the city can steer their operation because it is responsible for land use planning of all land areas and can thus steer construction through city plan provisions. Another instrument for steering is plot transfer conditions for areas of land owned by the city.

Planning begins with a master plan that sets guidelines for urban spatial planning. For construction areas or plots, a city plan determines in more detail what can be built within in the plot and how. The city plan can be very general, allowing plenty of freedom for the constructor in planning the building stock. However, city plan provisions may also be very specific. With regard to circular economy, the city plan can determine e.g. construction material, building height, direction of panes of roof, production regulations for renewable energy, the amount of green areas in relation to the lot area (blue-green factor), the number of shared use spaces and related criteria, the number and location of storage spaces for bikes, charging points for electric cars, reservation of spaces for shared use spots etc. Through the city plan, the city can effectively advance the implementation of circular economy. In terms of plot transfer conditions, the City of Turku has organised plot transfer competitions where competing construction companies set themselves climate friendly actions that they will implement in construction if the plot is allocated to them. The steering

[66] Based on material gathered during interviews

[67] https://www.motiva.fi/ratkaisut/energiatehokkuussopimukset on 23 February 2019

impact of the city has an important role, as it advances the development of activities of construction companies as well as development of concrete solutions in terms of more environmentally friendly construction. Consumer demand has a strong steering effect on construction companies. Environmentally conscious demands by both the land use planner and clients effectively steer the operation of construction companies towards implementing circular economy solutions.[68]

The City itself carries out construction primarily in infrastructure, such as earth construction, transport networks and construction of green areas as well as water areas. In terms of circular economy, one area that has become highlighted over the last years in the Turku region is the circular economy of land mass treatment. This includes for example, clean surplus masses, mildly contaminated threshold value lands and dredged materials. The role of circular economy in land masses is in their purification process and in the use of land masses in suitable locations when building infrastructure. The masses will be processed and used as locally as possible and close to their final disposal site. In other words, the objective is to maintain an optimal mass balance. Demolition material from buildings can also be used in building infrastructure. For instance, demolished concrete can be reused in building infrastructure or yard construction.[69] Also the choice of construction materials has significant climate impacts. Rock types and their origin as well as the use of local and recycled products are taken into consideration in construction when possible. A pre-assessment model for investments helps to notice that the costs and the basis of carbon dioxide emissions begin to form already at an early planning stage. The model also helps to figure out reasons why a choice that would be environmentally optimal has not been made in the process.[70]

In the construction phase, it is possible to significantly affect the energy consumption during the life cycle of a building. Energy solutions in the field of construction entail significant opportunities for circular economy, such as the recovery of renewable energy and residual waste and maximisation of energy efficiency, which means minimising the energy needed for heating and building services engineering. So far, the use of renewable energy and waste heat has been limited by challenges in storing them. In the Turku region, this has been solved e.g. by storing heat in the soil with the help of energy piles and by building a two-way district heating network that also functions as an energy storage.[71] Solutions of energy storage have been taken into use in the Skanssi area and a storage solution is being built in the Turku Market Square underground parking lot.

Construction materials have a significant role in the implementation of circular economy. The choice of construction materials has an impact on the carbon footprint in production phase, durability during use, opportunities and measures in the maintenance phase and finally usability in the demolition phase. Life cycle thinking, and recycling of construction materials have not been particularly taken into consideration in buildings that are currently being demolished. For this purpose, the handling and recycling of demolition waste is challenging. In the planning phase of construction projects, tools are needed to advance circular economy objectives and to support decision-making e.g. regarding construction materials. In

[68] Based on material gathered during interviews

[69] Based on material gathered during interviews

[70] Based on material gathered during interviews

[71] Based on material gathered during interviews

2017, the Ministry of Environment published an environmental guide that includes a green public building procurement guide[72] as well as the procurement criteria for low-carbon building.[73] These are voluntary recommendations based on recommendations of the European Commission.

The “Method for assessing the carbon footprint of buildings” which is being prepared by the Ministry of the Environment will take the work onwards, focusing on finding emission reductions at the beginning and end of building life cycle. The method covers the production of construction materials, their transportation and use, repair, demolition at the end of life cycle and recycling.[74] Developing this method is part of the roadmap of low-carbon construction, published in autumn 2017. The objective of the roadmap is to have instructions in Finland regarding carbon footprint in construction by 2025.[75]

Key projects within the theme of buildings and construction in the Turku region

- The Smart Learning Environments for the Future project (Tulevaisuuden älykkäät oppimisympäristöt). Efficient utilisation and planning of spaces with the help of data.
- The project ’Energy Wise Cities (EKAT) advances solutions that support energy efficiency in the use and maintenance of the city's residential properties and service properties and involves building users in order to attain energy objectives.
- The CircVol project promotes utilisation of large-volume land masses and side streams in the city for construction of land and infrastructure.
- The LÄMPÖÄ project studies all year round thermal energy storing in the soil with the help of energy piles, and utilisation of thermal energy as a source of additional energy for properties.
- Themes of the Circwaste project include resource efficiency in construction and the utilisation of soil materials.

Challenges and future opportunities of circular economy in buildings and construction

In the interviews conducted for the study, some challenges related to buildings and construction were identified[76]. Concerning spatial projects, the development of life cycle data and perspective still requires time and measures. Determining quality criteria for competitive tendering criteria in construction is difficult. As a result, price is often the factor determining the final decision. For land use planning, more verified information and concrete operating models are needed to advance carbon neutrality in land use planning

[72] http://urn.fi/URN:ISBN:978-952-11-4744-9 on 25 February 2019

[73] http://urn.fi/URN:ISBN:978-952-11-4744-9 on 25 February 2019

[74] http://www.ym.fi/fi-FI/Maankaytto_ja_rakentaminen/Rakentamisen_ohjaus/Vahahiilinen_rakentaminen/Rakennusten_hiilijalanjaljen_arviointime(48507) 23.2.2019

[75] http://www.ym.fi/fi-FI/Maankaytto_ja_rakentaminen/Rakentamisen_ohjaus/Vahahiilinen_rakentaminen/Tiekartta_rakennuksen_elinkaaren_hiilijalanjaljen_huomioimiseksi on 25 February 2019

[76] Based on material gathered during interviews

work. Construction is a materially intensive field with abundant potential for developing circular economy, but it is at the same time conservative and puts cost structure first. More understanding of material selection and recyclability of materials is needed in construction. Having access to value chains in construction at an earlier stage would be necessary. Product development of construction materials is an important area that requires knowledge of chemistry and qualities of different materials. Furthermore, the area is difficult to have a direct impact on.

In the interviews conducted for the study, the following opportunities related to buildings and construction were identified. In these areas, progress can be made in the Turku region over the next decade[77]:

1) Combining databases in the construction phase and the maintenance phase.
2) Further developing Skanssi as an innovation platform and pilot object. The objective is to create a pilot area focused on sustainable mobility, ecological planning and smart communal services.
3) Stabilising land masses with the help of industrial side streams.
4) Sustainable construction in a way that problems don't occur with humidity or indoor air.
5) Regional recycling and utilisation of soil material and mineral aggregate
6) Increasing utilisation of ashes in construction of infrastructure
7) Solving the treatment of dredging sediments when they are no longer disposed of at sea
8) Developing life cycle steering models for construction
9) Utilising building data models, infrastructure data models and spatial data models for simulation and creation of usage scenarios
10) Collaboration between cities and large construction companies to advance wood construction
11) Developing collaboration with construction companies through stakeholder forums
12) Improving the utilisation rate of facilities e.g. at the Old Great Square as part of its development
13) Developing storage of energy in new buildings.

[77] Based on material gathered during interviews

WATER-FOOD-ENERGY NEXUS

"Water-Food-Energy Nexus - Implementing systematic approaches to link and close the loops between water-food-energy and applying nature-based solutions to regenerate cities with natural features."

ICLEI aims at creating systematic approaches between the water, food and energy sectors. The examination of this area begins by mapping out actors in the three sectors in the Turku region, simultaneously identifying interfaces between them.

Realisation of circular economy in the water-food-energy nexus in the Turku region

Turku is one of the founding members of the Union of Baltic Cities, established in 1992. The city network has 85 member cities from Bergen to St. Petersburg. The objective of UBC is to widely support cities around the Baltic Sea in different sectors. UBC consists of six commissions, one of which, the Union of the Baltic Cities Sustainable Cities Commission, is based in Turku and has a personnel of 18. Legally speaking, UBC is a project development unit under Turku City Group. Water and water-related projects are one of the focus areas of UBC.

For the City of Turku, the most important water-related projects include local water treatment and waste water treatment, in the areas of which Turku has enough unique expertise. In many municipalities, waste water treatment is the biggest consumer of energy, but Turku is among the few cities where this process produces more energy than it consumes. From the perspective of circular economy, it is essential to utilise resources in waste water, such as sludge and energy. The current waste water treatment plant is a regional solution with neighbouring municipalities. It is located underground in the centre of the city, inside a rock. The waste water treatment plant in Kakola is a unique plant built underground, where steady con-

ditions enable the optimisation of the treatment process. Facilities located under the ground are not sensitive to storms, winds, rain or cold that would cause additional costs or challenges. Costs of waste water treatment are evened out by recovering energy from waste water. A heat pump is used to recover district heat that will allow 15,000 apartments around Turku to be heated. During summer, the plant produces district cooling. In addition, biogas is produced from waste water sludge and end use of sludge among land masses or in agriculture is developed. Presently, the plant produces 10 times more than it consumes. The plant also has solar panels for energy production and local technologies are tested there.[78]

Turku used to be infamous for bad-tasting water. Currently, artificial groundwater is used as a regional solution. It is produced by pumping water into infiltration basins, where over the course of three or four months the water is filtered and cleansed, becoming groundwater. Three different sources of clean water are being used in the Turku region, which is unique even in Europe. Turku has been piloting turning of water-steering pumps into turbines that produce energy instead of consuming it. Turbines have been taken into use e.g. in the feed-water pipes for groundwater from Virttaankangas to Turku and in local stormwater streams, enabling the recovery of energy produced by water movement.

Protection of the Baltic Sea has a key role in the circular economy of water in the Turku region. Local higher education institutions such as the University of Turku, Åbo Akademi and Turku University of Applied Sciences conduct a lot of research e.g. related to phosphorus with the objective of reducing the amount of phosphorus ending up in the Baltic Sea.

Key projects related to water in the Turku region

- The project Fosforit kuriin ja kiertoon ("Managing and recycling phosphorus") is a collaborative effort of higher education institutions to find solutions for protecting the Baltic Sea from agricultural emissions.
- The Sea based project includes assessment of actions for improving the condition of the sea area by reducing internal strain. Some of the actions may also help support circular economy by recycling nutrients from sea to land.
- Interactive Water Management aims at improving waste water management in the Baltic Sea Region by developing the capacity of the waste water treatment operators and implementing pilot investments to increase energy efficiency and advance sludge handling.
- iWater is a development project of stormwater management.
- The SAVE project collects practical experiences of the logistics and use of gypsum and specifies previous conceptions of watercourse effects of gypsum.
- BSR Water Platform promotes collaboration between different fields to develop information sharing and operating models related to smart water treatment. It strives to influence decision-making to advance preconditions of water treatment.
- China Europe Water Platform is a project related to legislation, research and business. Turku participates in the operation of the project.

[78] Based on material gathered during interviews

Southwest Finland is a key area for Finnish agriculture, food production and the focus area of fishery. There are several large food industry companies in the area, including Raisio and HK Scan. Many research and project activities taking place in the area are related to food and the circular economy of food.

The University of Turku carries out extensive research in matters related to food and agriculture through Functional Foods Forum, the Brahea Centre and the research of the Food Chemistry unit. Research involves e.g. food chains in agriculture, reducing food waste, developing plant proteins, using fish of less value in the fish industry and increasing the appreciation of food. Aistila is a sensory laboratory of the University of Turku focused on studying the sensations produced by food in consumers. The research restaurant Flavoria is also located in Turku. Sodexho, the City of Turku and the University of Turku are together building unique infrastructure in Flavoria. Topics studied in Flavoria include sustainable functions related to the food chain, eating, and understanding of the consumer experience. Flavoria is strongly developing towards a future of circular economy. An application that includes the selection history and bio waste history is available for the consumer. Flavoria also offers companies an opportunity to test their products in the research restaurant.

In the case of food and food chains, research and projects are combined in collaboration between local and national actors. The ELY Centre is working to advance circular economy in agriculture and forestry, while ProAgria produces expert services in agriculture, water management and fishery. Of the research fields of the Natural Resources Institute Finland, the Innovative Food System programme can be found directly under this theme. The Finnish Environment Centre monitors the state of the environment and long-term environmental changes, circular economy being one of their themes. The objectives of MTK Maataloustuottajien Varsinais-Suomen liitto (Central Union of Agricultural Producers and Forest Owners, the Southwest Finland regional organization) include carbon neutral food and strengthening carbon sinks. In terms of agriculture, circular economy is focused on improving soil using side streams (i.e. different biomasses) of agriculture and forestry, circulation of nutrients and utilisation of side streams.

Key projects related to food in the Turku region

- The development project of the food chain in Southwest Finland VARRU brings together regional actors in the food chain.
- The FoodiEX project finds solutions to increase the use of new and less valued bio food ingredients such as insects and weeds by involving consumers and understanding a multisensory experience.
- The Blue Products project advances the increasing of value gained from Finnish fish.
- In the Food Bait project, small companies use their promising ingredients to develop products that consumers want.
- Several projects focusing on reducing food waste: “VäKi – Less waste, more circularity”, “Saa Syödä!” the Innovative Food Supply Chain Programme and the Roadmap on Food Waste
- The project “Prote – responsible protein” strives to increase the local utilisation of responsibly produced and processed protein in the food chain. ScenoProt strives to develop new sources of protein for the food industry.
- The objective of the project Maan vesitalous ja kasvukunto (“Soil water management and soil health”) is transmitting research data and concrete experiences related to water management in fields, improving soil health and utilising manure and recycled nutrients.

A key actor in energy production in the Turku region is Turku Energia. Increasing renewable energy in production is a core theme on the basis which all investments are made by Turku Energia. The objective for year 2020 is to have 50% of electricity and heat renewable. The most significant development areas include the renewal of primary production and the Naantali multi-fuel power plant where e.g. biomasses that are side streams of the forest industry can be processed into energy. Renewing the district heating network entails solutions that enable circular economy, e.g. a two-way power grid, the use of low temperature heat, recovery of waste heat, district cooling and storing heat in thermal batteries. Turku Energia buys most of the electricity from the market, sells solar panels for consumers and maintains a solar power station in which the consumer can rent a panel. Turku Energia also has holdings in the production of renewable energy.[79] The power grid enables a two-way mechanism, and private producers of energy can sell any surplus energy to the power grid.[80]

The recovery, storing and use of waste heat are interesting in regard to circular economy. It has been estimated that there is more waste heat than is needed for heating buildings, but the lack of synchrony between peaks in production and use is challenging. The optimal way to store and use waste heat is near the target and economies of scale have an important role in harnessing waste heat. Waste heat is created e.g. during the summer when buildings warm up, on asphalt fields, on roofs, in groundwater and waste water and in the functioning of large industrial machines. Turku Energia utilises lost heat from the waste water treatment plant where heat pumps recover final energy from waste water. Turku Energia also uses waste heat from the printing machine of Turun Sanomat. Moreover, Turku Energia is actively searching for new sources of waste heat to be used. During summer, district cooling can be efficiently produced from waste heat. During winter, even smaller sources of waste heat are of interest.[81]

Sludge is collected at the waste water treatment plant in Turku and used for producing biogas at the Topinoja plant of Gasum. The plant is currently subject to considerable investments. The investments will enable increasing agriculture and other bio streams. Moreover, they will enable the production of transport biogas, and therefore Gasum is planning more gas refuelling points for vehicular traffic.[82] Biogas has raised interest e.g. as traffic fuel, and when the City of Turku renews its buses, biogas-fuelled vehicles are an option. Biogas is a product of circular economy and it is generated during the processing of organic waste such as food waste, sludge from the waste water treatment plant and agricultural manure and field biomasses. 83 Furthermore, vocational school Livia has a biofuel plant in the Turku region.

Research on energy has been widely carried out e.g. in the Finland Futures Research Centre, where renewable energy and the future of energy have been studied in many research projects. The Åbo Akademi Process Chemistry Centre studies combustion processes and Turku University of Applied Sciences has a research group called Uusi energia – New Energy.

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[79] Based on material gathered during interviews

[80] Based on material gathered during interviews

[81] Based on material gathered during interviews

[82] Based on material gathered during interviews

[83] https://www.gasum.com/kaasusta/biokaasu/biokaasu/miten-biokaasua-tuotetaan/ on 23 February 2019

Key projects within the theme of energy in Turku region

- The Civitas Eccentric H2020 project aims at promoting the use of biogas.
- The Citizens' energy transition project is focused on renewing energy production and turning it carbon neutral in order to attain the climate goals set for Turku. Actions include considerably increasing renewable energy, improving energy efficiency and using smart new energy solutions.
- The HUKATON project creates new overall solutions based on waste heat recovery in order to incorporate selected property types into a smart energy system from the demand response perspective.
- The Biofficiency project studies developing energy plants and heating plants for biomass fuel.
- The Waste to Energy 2030 project is focused on studying how ashes can be used in a purposeful way. The project also studies how additives affect the combustion process, how combustion gases react and what happens on a molecular level.
- NegativeCO2 is a research project looking at capturing carbon dioxide from burning biomass with the objective of developing innovative and potentially revolutionary Bio-CLC technology (Chemical-Looping Combustion of biomass).
- From Failand to Winland is a research project related to food safety, water safety and energy safety.
- The project FutWend examines external engines of energy transition, the roles and mental models of actors, energy policies and institutions that are contributing to a transition.
- The Great Electrification in Peer-to-Peer Society project presents in popular terms the development of renewable energy production and use as well as society of the future where energy production is emission-free, and the energy system is almost entirely electrified.

Challenges and future opportunities of circular economy in the water-food-energy nexus

In the interviews conducted for the study, some challenges related to the water-food-energy nexus were identified.[84] Clean water is globally one of the most endangered resources and solutions are needed to handle it. The share of energy production and energy use in carbon dioxide emissions is considerable, and agriculture is also one of the main causes of climate effects. The system has been built to rely on fossil fuels and changing this basis requires persistent work.

The sales of vegetarian food have increased, but simultaneously the use of meat is growing, which results in an increased amount of bio waste. With regard to food, the challenge of circular economy investments is due to food prices. Many base their decisions on price, and the group of consumers that is prepared to pay more for sustainably produced food is smaller. Food should be produced in a sustainable way but the criteria have not been clearly defined. Using side streams of plant products often has obstacles such as safety and questions of taste. These issues need to be resolved in order to be able to advance circular

[84] Based on material gathered during interviews

economy. Food waste and food ending up as organic waste remain great challenges. Pertaining to food, the Turku region has a severe lack of such circular economy activities that the future should be built on.

Compared to the rest of Finland, the varieties cultivated in Southwest Finland are more diverse. On the other hand, climate change rapidly affects changing cultivation conditions. Therefore, regional preparation is very important.

In the interviews conducted for the study, the following opportunities related to the water-food-energy nexus were identified. In these areas, progress can be made in the Turku region over the next decade.[85]

1) With regard to waste water treatment and production of drinking water, there is expertise in the Turku region that is directly exportable and in demand.
2) Agency in the food industry is strong in Finland. Even though resources are limited, much of such information is produced that can be used to develop food chains.
3) Using food waste and organic waste efficiently as biogas.
4) Circular economy solutions of ecological recycling/nutrient cycles. Southwest Finland is an important producer of Finnish food.
1) Utilisation of the nutrient potential of bigger masses and mapping out risks should be examined more closely. This can be done once there are resources and enough potential in the waste components.
2) Development of bio-based and renewable systems in energy production, as a large share of the carbon footprint comes from energy production.
6) Developing large-scale storing of electricity and heat
7) Making use of the contacts and expertise of circular economy experts
8) Development of training related to circular economy of energy and storage in soil.
9) Openness and involvement of individuals in energy
10) Visualisation and gamification of energy
11) Reducing emissions caused by energy systems and mobility systems
12) A platform for actions advancing the goal of Turku to be carbon neutral by 2029. The platform will be managed by the City of Turku and the content will be produced by projects.

[85] Based on material gathered during interviews

DATA IN CIRCULAR ECONOMY

The role of data in circular economy

In addition to the six thematic sectors of ICLEI, the mapping process of businesses resulted in discovering many businesses where circular economy related operations were linked to data production, handling and distribution of data and information as a service for advancing circular economy. Information is a theme spanning various ICLEI sectors and the role of information in circular economy is so significant that it merits a section of its own in this study.

The spearhead project Smart & Wise Turku is based on opening up data and harnessing it in order to save resources. Supply chain management, bar codes, digital identifiers and individualisation of material are also crucial for circular economy actions and efficiency of supply chains and they are all based on data and its utilisation. Analysing, planning and development work are largely based on existing data and making use of it as a basis for an improved or enhanced process. Wireless data transfer solutions enable the functioning of several industrial applications ranging from distribution of electricity to wind power stations. They also act as resource optimisers in precision farming and reduced energy consumption in harbour logistics. Moreover, they handle real time passenger information, surveillance systems and environment monitoring, all of which promote effective use of resources.[86]

Sharing platforms are a considerable form of circular economy based on data. Several sharing platforms are used in the Turku region and they include vehicles, fleet management, working facilities, virtual meeting tools, occupational psychology expertise, finding experts in different fields, experience production and

[86] https://www.satel.com/fi/etusivu/ on 26 February 2019

equipment for carrying children. What makes platform economy circular is the high utilisation rate of the product in proportion to private use.

Here, data refers not only to technological existence and handling of information but also to smartness of the entire organization and ecosystem, used for developing sustainable solutions. Information, understanding and creativity are key requirements for advancing circular economy.

Key projects within the theme of data use in the Turku region

- The purpose of the Open Data as a Service project is to open new business opportunities in leading themes of open data that include circular economy, smart transport and digital transformation.
- The “Smart Turku as a client, pilot tester and testing platform” market dialogue was based on harnessing data e.g. in developing city logistics, utilising land masses, safety planning and in reinforcing technology training.
- In the Smart Learning Environments for the Future project, data is used e.g. for space management and optimisation of energy use to advance circular economy.
- The project ELLE – “Energy-related business development in Southwest Finland” makes use of open data as part of developing operating models.

CIRCULAR ECONOMY EDUCATION IN THE TURKU REGION

Development and implementation of circular economy requires not only information but also experts. In order to turn circular economy into the dominant operating model instead of a linear economy, we need people who understand the principles of circular economy and who know how to put them into practice in their own field. There are several universities and upper secondary vocational education institutions that provide training in fields where circular solutions and the education thereof are important. All Finnish universities of technology either offer education in bio economy and circular economy or offer education that has the potential to advance bio economy.[87] However, whether the number of students is sufficient and whether expertise is comprehensive enough to match the needs of circular economy are matters of concern.[88]

Turku University of Applied Sciences is a very pragmatic actor in circular economy in the Turku region in the field of circular business operating models, built environment and chemical engineering. It is mentioned in the strategy of Turku University of Applied Sciences that circular economy brings growth. In Turku University of Applied Sciences, there are three significant development projects for education in circular economy. Moreover, the curriculum includes courses in circular economy and circular economy projects that are carried out in collaboration with businesses.[89] Turku University of Applied Sciences is the only

[87] Based on material gathered during interviews

[88] Based on material gathered during interviews

[89] Based on material gathered during interviews

Finnish member in the Ellen MacArthur Foundation which is a central actor in circular economy. With regard to built environment and chemical engineering, the significance of circular economy could be more highlighted in the content of education. Turku University of Applied Sciences offers Bachelor of Engineering degrees in bio-engineering and chemical engineering, energy technology and environmental technology, and civil and construction engineering.

In biochemistry, the University of Turku offers Bachelor of Science and Master of Science degrees, Master of Science (Technology) degrees in biotechnology, and Master of Science degrees in molecular plant biology, food chemistry and bioenergetics. In the field of chemistry, the University of Turku offers Bachelor of Science and Master of Science degrees. There are also international programmes available, such as Food Development and Materials Chemistry. A minor study module in sustainable development, open to all students, has been available for 10 years, and circular economy has a significant role in it. In addition, a training module focused on circular economy, environment and the maritime cluster has been available, linked to regionally strong maritime navigation expertise. In the field of organic and inorganic chemistry, the Åbo Akademi Process Chemistry Centre offers Bachelor's degrees and Master's degrees in chemical and process engineering, Bachelor's degrees in biosciences and Master of Science degrees. Depending on their interests and focus of studies, such graduates may be very well-equipped for working to advance circular economy. Through research in bio economy at the Raasepori unit and research in sustainable energy technology at the Vaasa unit, Novia University of Applied Sciences also has the potential and expertise to advance education in circular economy.

In vocational education, Livia offers vocational education and training as well as further vocational education and training in bioenergy, nature and environment and in fishery. Raseko is a vocational training centre that offers, for example, training in food industry product development, textile industry, property management and housing construction. Novida provides vocational training in Lieto, Loimaa and Uusikaupunki.

Examples of different fields of training where circular economy education is important include agriculture, process industry, textile industry, construction sector and building services engineering. Novida has also developed circular economy learning material for students in upper secondary education. Turku Vocational Institute offers vocational education and training in the food sector, laboratory technology, construction sector, building services engineering and textile industry. The Turku-based unit of Spesia Vocational College offers professional cook training and training in property and premises maintenance. Turku Vocational College Foundation offers qualifications for future construction sheet-metal workers, property maintenance operatives and restorers. Adult Education Centre Turku offers a wide selection of training in construction, sanitation industry property maintenance services.

In the framework of this study, the kind of role that education in circular solutions has in the qualifications of the above-mentioned institutions has not been examined in detail. What is essential is the significant availability of education and training in these fields in the Turku region. Education and training largely determine what kind of experts in circular economy we will have in the region in the future.

ANALYSIS OF ACTORS IN CIRCULAR ECONOMY IN THE TURKU REGION

The objective of this feasibility study was to analyse the state of circular economy in the Turku region and to find out what sort of prerequisites actors in this region have for participating in the activities of ICLEI Green Circular Cities Coalition.

Generally, a significant amount of activities following and advancing principles of circular economy take place in the Turku region. The City of Turku, its strategic entities, the Regional Council of Southwest Finland and service centre Valonia, regional higher education institutions and other regional and national actors have been active in advancing circular economy. At the same time, it is evident that much remains to be done in each sector before the economic operating model can be changed in a way to turn circular economy into the preliminary model of production and operation.

In order to develop circular economy, it is important that not only productional circulation is implemented but also the financial point of view is taken into consideration – circular economy must become economically feasible. This does not necessarily mean only procurement or production costs but rather life cycle costs, for which calculation models are currently being developed. Regardless of the type of costs and implementation method of circular economy, someone must pay the expenses. Moreover, in addition to environmental impact there must be financial arguments to back circular economy for it to become widespread. The core of circular economy is in planning. To enable well-functioning circulation, it is crucial to focus on transformability of services, products and processes, areas and facilities already in the planning phase.

When planning the ICLEI international GCCC network and collaboration, it is essential to reflect on what the City of Turku and the region hope to gain from GCCC collaboration. Should we bring such expertise to the network where the Turku region is ahead, or should we select themes where other network members have more to give to actors in the Turku region? Would it be most useful to select themes where it is necessary for us to improve? Perhaps we should also think about which themes could benefit most

from this process. Before selecting collaboration themes, it would also be important and sensible to examine the situation in other cities and reports on which themes they intend to bring to the GCCC network, which themes they need help with to advance and which themes they have unique expertise in.

In any case, it is important to locally identify areas of spearhead expertise as well as blind spots where we have room for improvement. Becoming a leading country in circular economy is possible only if we learn to look at produced services and functions in a new way in all industries and sectors. The starting point of this study is the view that each theme has room for further development and a closer analysis can be done e.g. in relation to the areas of expertise in the ICLEI network when we learn about the situation in other cities.

Considering practical realities and the effective use of resources, it is probably most practical for the Turku region to select themes that are in any case intended or necessary to implement. The Turku region can then turn to the network for perspective and development collaboration. As part of this feasibility study, the interviewees were asked about their interest and resources for participating in international collaboration in the framework of the GCCC network. The response was mainly positive, in some cases even enthusiastic, provided that the topic would be relevant, the content would be appropriate and solid and that the network would bring concrete benefit to advancing circular economy in the area. It was considered that the City of Turku should primarily take the role of coordinating cooperation because ICLEI themes are city-oriented and external actors have little chance to influence internal affairs of the city. Another shared view was that in order to reflect the mindset of the City of Turku, those responsible for collaboration and themes should be key decision-makers in city divisions.[90]

The themes listed below have come up in the data in one way or another by several actors. During interviews, actors in these fields have expressed interest towards ICLEI collaboration but themes, operating models or potential actions have not been confirmed with the relevant actors. Before the final decision on themes selected for ICLEI GCCC collaboration, they should be discussed and planned in more detail directly with actors in the sector.

From the viewpoint of land use planning, interesting topics in the theme of urban spatial planning and governance include the steering impact of land use planning, which has been implemented and is developed in the future in the Skanssi area. This regional expertise could be further developed, and land use planning practices and expertise that advance circular economy could be brought to the network. In addition, the spearhead project Smart & Wise includes interesting areas such as the model of anticipatory urban spatial planning, city modelling and development of electric transport. In the theme of governance, the importance of participation is highlighted in Turku. In the future, it will become an increasingly important resource of administration in both decision-making and in the development of residents' activities. Participation can be further developed, and it could make an interesting theme to be spread even in the GCCC network. Citizens' energy transition provides concrete actions and it has had a visible role in the involvement of city residents and companies.

In the theme of public procurement, it would be interesting to collaborate with a wider network of cities to develop and test good practices and to apply them. For example, carbon footprint calculation and its standardisation as part of public procurement could internationally support and advance the circulation of

[90] Based on material gathered during interviews. The list of interviews conducted for the feasibility study in Appendix 1.

materials, because carbon footprint calculation automatically favours solutions where either recycled or recyclable materials are used. Carbon footprint calculation in public procurements would extend the practice and create prerequisites for it to function also as a basis for border customs. The assessment model of the life cycle impacts of the Smart & Wise spearhead project in city procurements and investments may set up development of collaboration. In the light of the study, the theme of public procurement seems to be the most evident theme where developing and spreading good practices through a network is preferable to carrying these activities out independently.

Likely key actors in this theme include Turku Science Park Oy and Turku University of Applied Sciences, as they have regionally the most comprehensive insight into industrial symbioses in the business field. If companies are also to be involved in collaboration, these actors are the most likely to reach suitable operators through their business collaboration partners. E.g. Smart Chemistry Park and functions linked around it, or the developing of Blue Industry Park could be suitable industrial symbioses to develop under this theme. Innovation activities carried out by Turku Science Park Oy, enabling collaboration between researchers and companies, could be an example of such local expertise that the network might be interested in. The symbiotic operation of Turku University of Applied Sciences with businesses in teaching circular economy is also an interesting operating model that could have value for other cities in the GCCC network.

In the theme of building and construction, the Turku region has a strong focus on treatment of land masses, which could also be of international interest. In construction, Turku could be a forerunner in piloting and adopting the method for assessing the carbon footprint of buildings, developed by the Ministry of the Environment. The criteria could be combined with city planning in a suitable and interesting construction area, at the same time developing innovation platform thinking in construction. Such mindset has already had a strong hold in the Skanssi area. Waste heat is an interesting sector and harnessing the energy of waste heat is a significant climate theme even in global terms, particularly in warm countries where using the energy of waste heat in cooling could mean considerable emission reductions even without a need for storaging.

In the theme of waste management, the Topinpuisto circular economy hub stands out. It has an operating model that could even be of international interest. In comparison with some of the other cities in the network, Turku is a small city but the model could also work on a broader scale, advancing recycling of material in larger cities. Another interesting issue in this theme is the regionally thriving expertise in textile recycling the pilot plant that will in all cases become a significant subject of development work in the Turku region in the upcoming year as Turku strives to ensure that the final plant will be placed in the area.

In the water-food-energy theme, regional waste water treatment in Turku is an example of circular economy of water and energy. According to information that came up in the study, it is also know-how with international demand. As a clean water solution, artificial groundwater is also an interesting theme. Research and action related to protection of the Baltic Sea also thrive in the Turku region and they may also be of interest to other circular economy cities. In terms of food, it might be possible for Turku to find actors to represent the entire food chain from agriculture to food production, utilisation of side streams, recovery of nutrients and production of energy from bio waste. Moreover, Foodtech Platform Finland has started operating in the region, combining food producers with technology companies and highlighting the environmental viewpoint of solutions. In terms of energy, Turku's partnering implementation in the Civitas Eccentric project includes the theme of biogas, which is an interesting challenger of the generally approved electric car paradigm of the future. The production of biogas has potential to be a highly significant future process enabling the recycling of petrol fuelled automobile fleet into biogas fuelled fleet.

It is useful to analyse the material more thoroughly, potentially even broaden and deepen the material as relevant by actors in circular economy in the Turku region.

Needs for Further Research

As this study is of extensive nature, it has not been possible to provide a deep insight into any specific area. Therefore, the themes have been studied and discussed to a limited extent. An in-depth further study on themes and actors is required before any decisions can be made regarding which themes are suitable for the ICLEI collaboration. Selection of the most interesting and suitable sectors and actors as the circular economy actors of the Turku area in the ICLEI GCCC network remains to be completed as will be agreed.

Outside the ICLEI themes, it would be interesting to map out the field of businesses and the views of businesses on their potential to develop circular economy activities to a greater extent. Namely, the businesses represent the large mass of actors that need to be involved in the development.

Education is the foundation of future expertise. This study made evident the relationship between higher education institutions and circular economy as well as the strong role of Turku University of Applied Sciences as a promoter of training in circular economy. It would be very interesting to map out future experts in circular economy more widely by entering higher education institutions and upper secondary institutions to study the level and width of training in circular economy and key expertise enabling it at the level of qualifications and courses.

Clarifying the concepts and terminology of circular economy and potentially mind mapping the activities in circular economy in the Turku region could be interesting and add to the comprehension of both actors in different fields and residents in the area.

APPENDIX 1.

Interviews conducted for the feasibility study

Riikka Leskinen, Valonia. Interview held on 7 November 2018
Aleksis Klap, Varsinais-Suomen Liitto. Interview held on 7 November 2018
Linda Fröberg-Niemi, Turku Science Park Oy. Interview held on 9 November 2018
Risto Veivo, City of Turku. Interview held on 19 November 2018
Piia Nurmi, Turku University of Applied Sciences. Interview held on 29 November 2018
Talvikki Välimaa, University of Turku. Interview held on 3 December 2018
Sanna Paloposki, Arkea. Interview held on 3 December 2018
Stella Aaltonen, City of Turku. Interview held on 5 December 2018
Mari Sandell, University of Turku. Interview held on 7 December 2018
Rami Savila, City of Turku. Interview held on 7 December 2018
Janne Mustonen, City of Turku. Interview held on 11 December 2018
Jussi Rantala, City of Turku. Interview held on 12 December 2018
Lotta Lyytikäinen, Turku Energia. Interview held on 12 December.2018
Leena Hupa, Åbo Akademi. Interview held on 12 December 2018
Björn Grönholm, Union of Baltic Cities. Interview held on 12 December 2018
Stefan Willför, Åbo Akademi. Interview held on 12 December 2018
Rauli Lautkankare, Turku University of Applied Sciences. Interview held on 17 December 2018
Outi Laikko, City of Turku. Interview held on 17 December 2018
Miika Meretoja, City of Turku. Interview held on 18 December 2018
Jouni Keronen, CLC. Interview held on 8 January 2019
Johanna Korpikoski, City of Turku. Interview held on 9 January 2019
Mikko Pohjola, University of Turku. Interview held on 9 January 2019
Leena Erälinna, University of Turku. Interview held on 10 January.2019
Mika Pitkänen, City of Turku. Interview held on 10 January 2019
Sini Ilmonen, Lounais-Suomen Jätehuolto Oy. Interview held on 11 January 2019
Olli A. Manni, City of Turku. Interviews held on 14 February 2019 and 15 February.2019
Timo Hintsanen, City of Turku. Interview held on 15 January 2019
Jaana Hänninen, Meyer Turku Oy. Interview held on 16 January 2019
Ann-Sofi Österberg, City of Turku. Interview held on 30 January 2019
Olli Hakala, ELY Centre for Southwest Finland. Interview held on 8 February 2019
Sanna Tikander, ELY Centre for Southwest Finland. Interview held on 8 February 2019
Anni Karhunen, ELY Centre for Southwest Finland. Interview held on 8 February 2019
Kaisa Leiwo, Turku Chamber of Commerce. Interview held on 15 February 2019
Terhi Haverinen, Varsinais-Suomen yrittäjät. Interview held on 15 February 2019
Taina Riekkinen, City of Turku. Interview held on 20 February 2019

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